



NCDMF Completion Report for Incidental Take Permit 1259

Sea Turtle Bycatch Monitoring of the 2000 Fall Flounder Gillnet Fishery of Southeastern Pamlico Sound, North Carolina

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July 2001

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INTRODUCTION

In November 1999, the North Carolina sea turtle stranding network noted significant increases in strandings in the southeastern portion of Pamlico Sound (Sea Turtle Stranding Report Zone 35, Inshore). During November and December, a total of 97 strandings occurred in this area. Following early stranding reports, National Marine Fisheries Service (NMFS) and North Carolina Division of Marine Fisheries (NCDMF) Marine Patrol conducted aerial surveys of eastern Pamlico Sound along Ocracoke and Hatteras islands to investigate fishing activities adjacent to the strandings. Marine Patrol checked gillnet sets and interviewed fishermen about set locations, gear parameters, and fishing practices. NCDMF Fisheries Management staff also investigated active fisheries by interviewing various fisheries participants collecting information on fishing practices, seasons, gear parameters, and frequency of sea turtle interactions.

Three active fisheries were identified: the shrimp trawl fishery; large mesh (> 5-inch stretched mesh) flounder gillnet fishery; and small mesh (< 5-inch stretched mesh) spotted seatrout gillnet fishery. Shrimp fishing activities in the area were heavy and NCDMF Marine Patrol boarded several trawlers, all of which were equipped with functioning Turtle Excluder Devices (TEDs). Concurrently, NCDMF Fisheries Management staff conducted at-sea monitoring aboard gillnet vessels in southeastern Pamlico Sound during November 22-24, 1999. Eleven observer trips were conducted, consisting of five trips aboard flounder gillnet vessels and six trips aboard spotted seatrout gillnet vessels. Two sea turtle takes were observed in the flounder fishery while no takes were observed in the spotted seatrout fishery. Considering this information, NMFS issued an emergency rule on December 10, 1999 closing southeastern Pamlico Sound to gillnets larger than 5-inch stretched mesh to protect endangered and threatened sea turtles (NMFS 1999). The closure remained in effect through January 9, 2000.

During the next six months, NCDMF, in consultation with NMFS, prepared an application for an Incidental Take Permit (ITP) under Section 10 of the Endangered Species Act (ESA). The ITP authorized implementation of management measures during the fall of 2000 to protect threatened and endangered sea turtles while allowing gillnet fisheries for flounder to be prosecuted within designated areas of Pamlico Sound. On October 5, 2000 NMFS issued ITP #1259 to NCDMF, which expired on December 16, 2000. A key component of the permit was a comprehensive conservation plan. The primary goal of this plan was to reduce sea turtle strandings in southeastern Pamlico Sound by 50% from September 15 through December 15, 2000 relative to 1999 strandings during the same time period. To achieve this goal, strict management measures and a comprehensive fisheries monitoring plan were implemented.

METHODS

ITP Conservation Plan

The first action taken by NCDMF was the designation of the Pamlico Sound Gill Net Restricted Area (PSGNRA) from September 15 through December 15, 2000 (Figure 1). This was the same area that NMFS closed the previous year due to large numbers of sea turtle strandings. All fishermen that employed large mesh (> 5-inch stretched mesh) gillnets in this

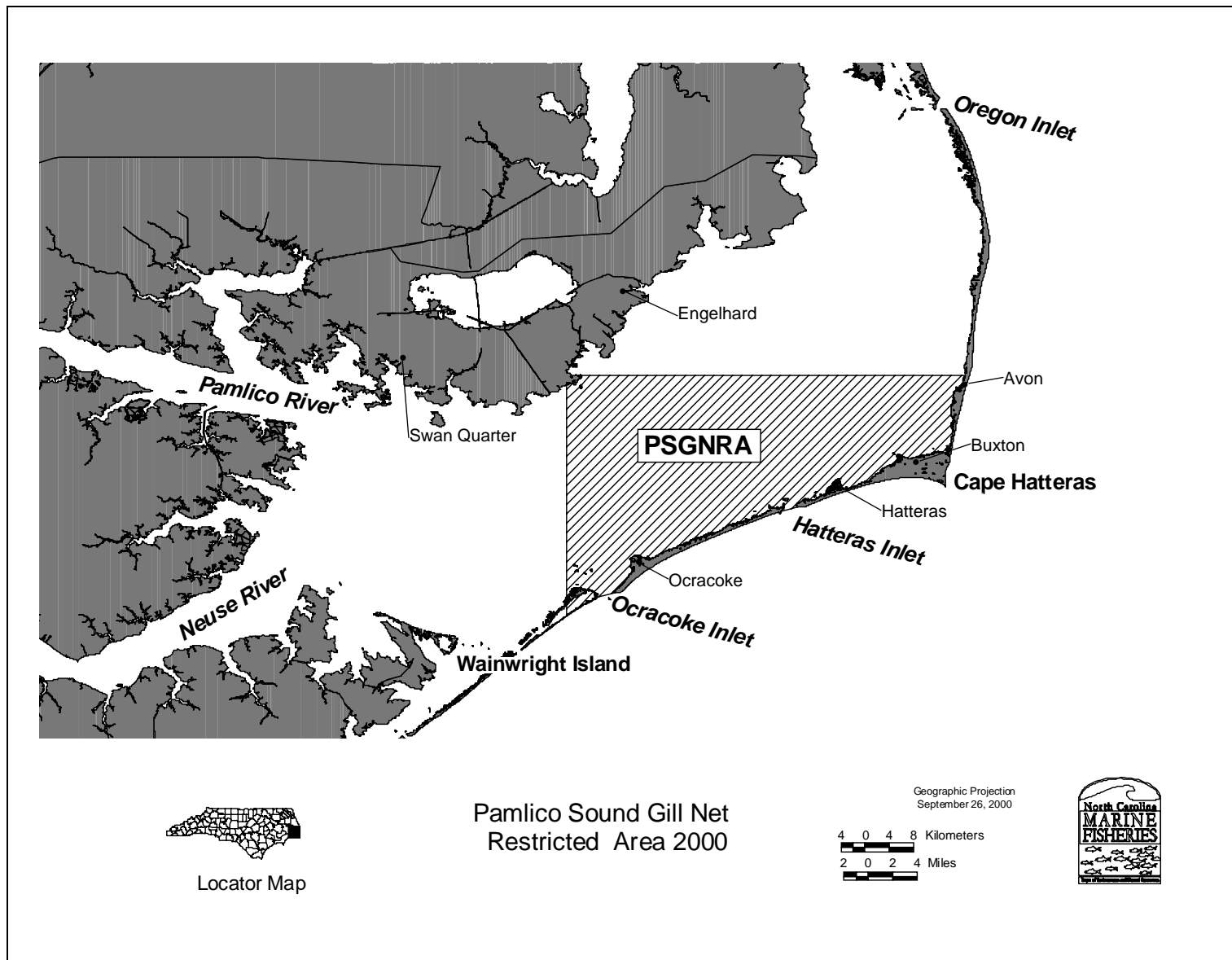


Figure 1. Map of southeastern Pamlico Sound and the Pamlico Sound Gill Net Restricted Area (PSGNRA)

area were required to obtain a permit from NCDMF. Provisions of the permit required a maximum yardage limit of 3,000 yards for large mesh gillnets, mandatory weekly reporting, mandatory sea turtle interaction reporting, and mandatory observer coverage. In addition, a multilevel management system based on observed fishery interactions and strandings was employed.

Permit Reporting

Permitted fishermen were required to provide weekly reports to NCDMF. The following information was provided by each fishermen for each large mesh gillnet fishing trip conducted within the PSGNRA between September 15 and December 15, 2000.

- Pounds of flounder landed
- Yards of gillnet set
- Soak time for each trip (days)
- Depth of water fished (<10ft or >10ft)
- Number of sea turtles caught
- The condition of any sea turtles caught.

Reports were submitted to NCDMF by noon on Saturday during each week of the fishing season. Failure to comply with these reporting requirements or providing false information resulted in permit suspension. In addition, fishermen were required to report all sea turtle interactions to NCDMF within 24 hours.

Sea Sampling

The PSGNRA permit also established mandatory observer coverage for the large mesh gillnet fishery. Permit holders were required to allow NCDMF fishery observers aboard their vessels to monitor catches. Failure to comply with this permit provision resulted in permit suspension. Observers were randomly assigned to permit holders by port, which included the Outer Banks port of Hatteras and the mainland ports of Engelhard and Swan Quarter (Figure 1). Engelhard and Swan Quarter were treated as one port. This was done because of the close proximity of these ports and the discovery that fishermen originating from these ports shared common fishing grounds. North Carolina Trip Ticket data indicated that trips were evenly distributed between Hatteras and Engelhard/Swan Quarter during the 1999 fishing season. Observer coverage was proportionally allocated by port based on the 1999 trip distribution. A target of 5% coverage was set prior to the initiation of the program.

A cooperative observer program was established consisting of observers contracted through an industry Fishery Resource Grant (FRG) and NCDMF employees. The contracted observers were NMFS certified and followed all Northeast Fisheries Science Center (NEFSC) protocols for gillnet fishery observers. Three NCDMF observers were also NMFS certified while other employees utilized throughout the season were not. Each observer was trained to identify, measure, and resuscitate sea turtles. Date, time, location (latitude and longitude, when possible) of each turtle taken, condition (e.g., no apparent harm, injury including a description of the nature of the injury, or mortality), species, sex (if determinable), straight carapace length, and disposition were recorded. Incidentally captured Kemp's ridley carcasses and carcasses of other species were brought to shore when feasible. All live debilitated sea turtles were brought to

shore for examination and treatment. Carcasses not brought in for post-mortem examination were marked either with external flipper tags or spray painted prior to disposal overboard. The NMFS certified observers were directed to collect data on gear parameters and bycatch for each haul. The landed catch was sampled at the end of each trip and a total flounder weight obtained. Other NCDMF observers were instructed to collect data on gear parameters and sea turtle bycatch for each haul and obtain a total flounder weight for each trip. The NMFS certified observers coded data on NMFS data sheets for gillnet fishery observers and submitted data to NEFSC for key entry. All observers were debriefed within 24 hours of each trip to collect data on total catch, set locations, gear parameters, and sea turtle interactions.

The total bycatch of sea turtles in the PSGNRA was estimated using the stratified ratio method. The bycatch rate (sea turtles caught per unit of fishing effort), estimated from observer data, was multiplied by the total fishing effort reported by the fishermen. The strata were spatial defined by the ports of Hatteras and Engelhard/Swan Quarter. The unit of fishing effort was pounds of flounder landed. Total bycatch estimates were calculated weekly by adding estimates for each port.

Multilevel Management

To achieve the goal of 50% reduction of sea turtle strandings during the 2000 fishing season relative to the 1999 season, a multilevel management system was devised. Four levels of management were established based on total sea turtle bycatch estimates and strandings. Maximum stranding levels were set by species and reflected 50% reductions for each (Table 1).

Table 1. Number of sea turtle strandings by species from September 15 through December 15, 1999 in southeastern Pamlico Sound, North Carolina and maximum allowed strandings for the same time period and area during the 2000 fishing season.

Species		1999 Strandings	2000 Max. Strandings
Kemp's Ridley	(<i>Lepidochelys kempii</i>)	46	24
Green	(<i>Chelonia mydas</i>)	20	9
Loggerhead	(<i>Caretta caretta</i>)	31	14
Species Aggregate		97	45

The maximum allowed number of takes was not easily agreed upon. The conclusion drawn by the Turtle Expert Working Group in 1998 indicated that it was difficult to determine what portion of at-sea mortality was reflected in strandings (NMFS 1998). After extensive consultations between NMFS and NCDMF an agreement was reached. The assumption that one in four turtles that were killed at sea reach shore was used to calculate the total allowable lethal takes for the 2000 fishing season. In addition, 50% discard mortality was assumed for the large mesh gillnet fishery. This mortality estimate was used to calculate the total allowable live takes. Maximum bycatch estimates were set by species for both live and lethal takes (Table 2).

The stranding and take levels listed in Table 2 were utilized to trigger the fourth and final level management response, which consisted of closing the PSGNRA to large mesh (> 5-inch stretched mesh) gillnets. Level three triggers were half the number of strandings and takes listed under level four (Table 3). Level three management responses were comprised of time/area/gear closures. Level two triggers were half the number of strandings and takes listed under level three (Table 4). Level two management responses were primarily made up of gear restrictions. Level

one management was imposed at the beginning of the fishing season and included designation of the PSGNRA, a maximum yardage limit of 3,000 yards for large mesh gillnets, weekly reporting requirements, and mandatory observer coverage.

Table 2. Number of sea turtle strandings by species from September 15 through December 15, 1999 in southeastern Pamlico Sound, North Carolina and maximum allowed strandings, estimated lethal takes, and estimated live takes for the same time period and area during the 2000 fishing season. Level four management responses required.

Species	1999 Strandings	2000 Max. Strandings	2000 Max. Estimated Lethal Takes	2000 Max. Estimated Live Takes
Kemp's Ridley	46	24	96	192
Green	20	9	36	72
Loggerhead	31	14	56	112
Species Aggregate	97	45	175	350

Table 3. Estimated observed lethal and live takes or strandings that triggered level three management responses during the 2000 fishing season.

Species	Strandings	Estimated Lethal Takes	Estimated Live Takes
Kemp's Ridley	12	48	96
Green	5	20	40
Loggerhead	7	28	56
Species Aggregate	23	92	184

Table 4. Estimated observed lethal and live takes or strandings that triggered level two management responses during the 2000 fishing season.

Species	Strandings	Estimated Lethal Takes	Estimated Live Takes
Kemp's Ridley	6	24	48
Green	3	12	24
Loggerhead	4	16	32
Species Aggregate	11	44	88

On October 5, 2000 NMFS issued the ITP to NCDMF, but disagreement over allowable stranding and take levels delayed the actual signing of the permit until October 24, 2000. Level one management measures were imposed on September 15, 2000 and NCDMF began actively monitoring the large mesh gillnet fisheries in the PSGNRA. Observed levels of sea turtle takes and strandings reached the thresholds specified for green turtles in Table 2 on October 24, 2000. This triggered a level four management response requiring NCDMF to close the PSGNRA to large mesh (> 5-inch stretched mesh) gillnets on October 27, 2000.

RESULTS AND DISCUSSION

Monitoring conducted by NCDMF during the 2000-fishing season indicates that the Pamlico Sound large mesh gillnet fishery consists of two major components. First, a shallow water fishery, which occurs along the Outer Banks and secondly, a deep water component, which operates further from shore along a slope adjoining the main basin of Pamlico Sound (Figure 2). Both of these fisheries target southern flounder (*Paralichthys lethostigma*).

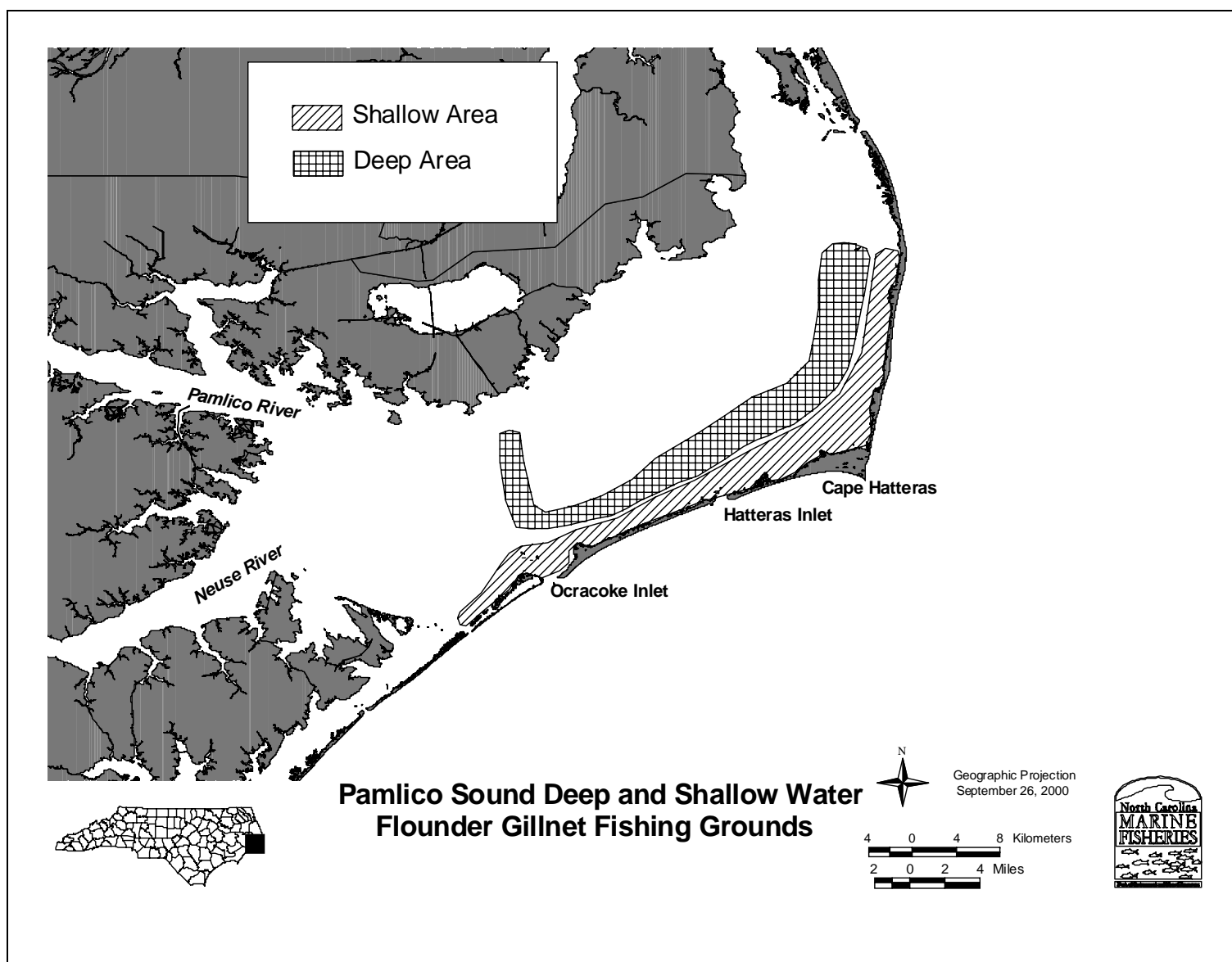


Figure 2. North Carolina estuarine flounder gillnet fishing grounds in Southeastern Pamlico Sound.

Fishery Description

Deep Water Fishery

The deep water fishery operates from September through December with fishermen setting nets along a slope adjacent to the main basin of Pamlico Sound (Figure 2). Fishing depths in this area range from 10 to 20 feet. Vessels are typical ocean sink gillnet boats ranging from 25 to 45 feet in length with each vessel operating with a two-man crew. Each fishing operation sets between 2,000 to 10,000 yards of large mesh (5.5- to 6.5- inch) gillnet, which are soaked for up to three days and retrieved with the aid of net reels. Sets are composed of 200 to 600 yard lengths of gillnet with most constructed of 0.5 mm twine. Net depths range from 8 to 12 feet with tie-downs 2 to 4 feet long attached to the float and lead lines at 50 feet intervals along the net. Tie-downs are used in this fishery to produce a bag or pocket of webbing, which increases catch efficiency of bottom dwelling flounder (Figure 3). There were 25 active participants in this fishery during the 2000 fishing season with most trips originating from Engelhard or Swan Quarter and a small portion leaving from Hatteras. This fishery developed approximately 10 years ago with a few fishermen setting a few thousand yards of gillnet. Since the fisheries inception, effort has steadily increased with more participants fishing more gear each year. During the past several years, gillnets have surpassed pound nets as the dominant gear for flounder in North Carolina's estuarine waters (Figure 4).

Shallow Water Fishery

The shallow water fishery operates from April through December in areas next to the barrier islands in Pamlico Sound (Figure 2). Fishing depths in these areas are typically less than three feet. Vessels are usually open skiffs ranging from 15 to 25 feet in length with one or two-man crews. Each fisherman sets 500 to 2000 yards of large mesh (5.5- to 7.0- inch) gillnet, which are soaked overnight and retrieved by hand. Sets are composed of many short lengths of gillnet with most constructed of 0.5 mm twine. Tie-downs are not used in this fishery but net depths range from 6 to 11 feet with sets occurring in depths less than 3 feet. This combination of water depth and net depth provides the same bag effect as the tie-down in the deep water fishery. There were 68 active participants that fished within the PSGNRA during the 2000 fishing season. This is the traditional flounder fishery, which extends both north and southwest of the PSGNRA along the Outer Banks.

Monitoring Summary

Flounder gillnet fishery monitoring began on September 15, 2000 and ended when the PSGNRA was closed to large mesh gillnets on October 27, 2000. Monitoring consisted of assigning permits, collecting logbook reports, and deploying observers in the shallow and deep water fisheries. All reporting and observer deployment and debriefing were done weekly to provide timely estimates of sea turtle bycatch for each fishery.

Permits and Reporting

There were 132 permits assigned during the six-week season with 93 participants reporting fishing activity. Sixty-eight were shallow water fishermen and 25 were deep water participants. Compliance with reporting requirements was marginal with 10.2% failing to report and 5.1% reporting late (Table 5). Failure to report rates varied throughout the period from a

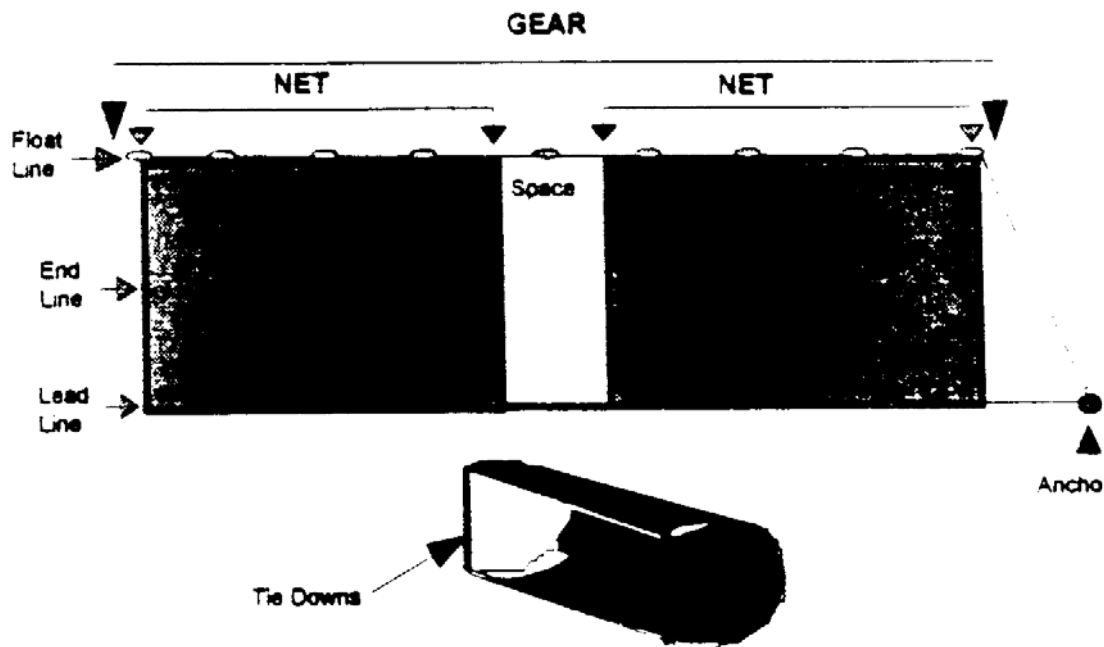


Illustration taken from Fisheries Sampling Branch Observer Manual, NMFS (1996)

Figure 3. Diagram of a sink gillnet. The sink gillnet is submerged below the water line and consists of several net panels attached together as a string. This gear can be modified through the use of tie-downs to target bottom-dwelling fish.

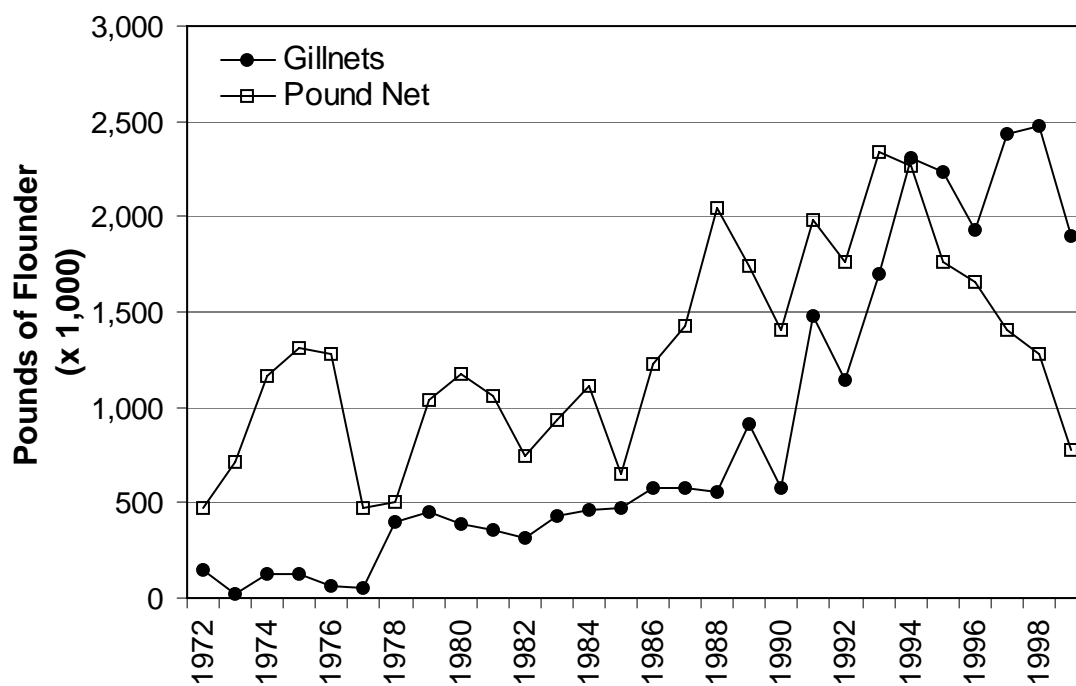


Figure 4. North Carolina gillnet and pound net flounder landings for 1972-1999.

low of 5.1% during the third week to a maximum 15.2% during the sixth and final week (Table 5). The closure of the PSGNRA was announced prior to the end of the sixth week resulting in higher non-reporting rates for the final week. Late reporting decreased as the season progressed from 14.4% the first week to 0.8% during the final week with 78.4% of late reports represented by participants that did not fish (Table 5). The seasonal trend in late reporting can be explained by the fact that many fishermen did not initially realize they had to report even though they did not fish. As the season progressed late reporters were educated about this requirement and compliance increased. Despite the many occurrence of late and failed reporting, permit suspensions were infrequent. Initially, permits were suspended for these violations but were promptly reinstated to give fishermen a second chance to comply with reporting requirements.

Table 5. Summary of PSGNRA permit reporting by week for the 2000 fishing season.

Week	Dates	Total Permits	%Failed	%Late	%Late "did not fish"
1	Sep-15 - Sep-22	111	11.7	14.4	87.5
2	Sep-23 - Sep-29	113	7.1	8.8	60.0
3	Sep-30 - Oct-06	117	5.1	2.6	100.0
4	Oct-07 - Oct-13	125	12.0	4.8	66.7
5	Oct-14 - Oct-20	129	9.3	0.8	100.0
6	Oct-21 - Oct-27	132	15.2	0.8	100.0
All	Sep-15 - Oct-27	132	10.2	5.1	78.4

The shallow water fishery had a total of 68 fishermen reporting 892 trips during the six-week fishing period between September 15 and October 27, 2000 (Table 6). Landings peaked in the shallow water fishery during the fourth week of the season with 16,943 lb of flounder reported (Table 6). Fishing effort peaked a week later during the fifth week with 41 fishermen conducting 190 trips and setting 235,990 yards of gillnet (Table 6). Ten sea turtle interactions were reported during the six-week fishing season with two reported as mortalities (Table 6).

Table 6. Summary of shallow water PSGNRA permit reporting by week for the 2000 fishing season.

Week	Dates	Active Permits	Trips	Total Gillnet Yards	Ave Soak Days	Total lbs Flounder	Reported Live Takes	Reported Dead Takes
1	Sep-15 - Sep-22	37	131	134,110	1.0	6,655	3	0
2	Sep-23 - Sep-29	37	117	125,980	1.0	6,482	0	0
3	Sep-30 - Oct-06	46	168	174,800	1.0	10,542	2	2
4	Oct-07 - Oct-13	42	153	173,040	1.1	16,943	0	0
5	Oct-14 - Oct-20	41	190	235,990	1.0	7,812	2	0
6	Oct-21 - Oct-27	34	133	157,090	1.1	7,764	1	0
All	Sep-15 - Oct-27	68	892	1,001,010	1.0	56,198	8	2

The deep water fishery had a total of 25 fishermen reporting 267 trips during the six-week fishing period between September 15 and October 27, 2000 (Table 7). Landings peaked in the deep water fishery during the fifth week of the season with 20,619 lbs of flounder reported (Table 7). Fishing effort also peaked during the fifth week with 23 fishermen conducting 85 trips and setting 224,700 yards of gillnet (Table 7). Twelve sea turtle interactions were reported during the six-week fishing season with five reported as mortalities (Table 7).

Total flounder catch was comparable between the two fisheries, even though there was a large disparity in the number of participants and trips. This is explained by the larger vessels in the deep water fishery, which are capable of fishing more gear. The deep water fishery averaged approximately 2500 yards of gillnet\ vessel\ trip compared to only 1100 yards for the shallow water fishery (Figure 5). In addition, soak times were longer in the deep water fishery when compared to the shallow water fishery (Figure 5).

Table 7. Summary of deep-water PSGNRA permit reporting by week for the 2000 fishing season.

Week	Dates	Active Permits	Trips	Total Gillnet Yards	Ave Soak Days	Total lbs Flounder	Reported Live Takes	Reported Dead Takes
1	Sep-15 - Sep-22	9	26	55,400	1.4	3,301	1	0
2	Sep-23 - Sep-29	8	21	41,000	1.4	2,587	1	2
3	Sep-30 - Oct-06	9	29	68,750	1.1	6,398	2	0
4	Oct-07 - Oct-13	14	47	110,800	1.2	15,819	2	0
5	Oct-14 - Oct-20	23	85	224,700	1.2	20,619	0	3
6	Oct-21 - Oct-27	18	59	155,500	1.4	15,698	1	0
All	Sep-15 - Oct-27	25	267	656,150	1.3	64,422	7	5

Sea Sampling

A total of 40 shallow water fishing trips were observed during the 2000 fishing season, achieving 4.5% coverage, which was just below the 5% target for the season (Table 8). Coverage of the deep water fishery included 25 trips attaining 9.4% coverage (Table 9). The larger vessels participating in the deep water fishery allowed for greater amounts of gear which, resulted in deep water fishery observers monitoring more yards in fewer trips when compared to the shallow water fishery. Observers monitored 59,950 yards of gillnet in the deep water fishery and 39,210 yards in the shallow water fishery (Tables 8 and 9). The deep water fishery averaged 2,398 yards of gillnet per trip, while the shallow water fishery averaged 980 yards per trip. In addition, soak times were greater in the deep water fishery averaging 1.3 days, while the shallow water fishery averaged one day. Differences in the average flounder catch per trip for each fishery reflected these effort differences with the deep water fishery averaging 280 lbs per trip and the shallow water fishery averaging 67 lbs per trip. No observer refusals were reported from either fishery and all trips observed adhered to yardage limits set during the six-week season.

Coverage of each fishery appeared to be adequate. Observed flounder CPUEs for each fishery tracked closely with the reported CPUEs for the entire fleet (Figure 6). Sea turtle bycatch estimates were calculated using the stratified ratio method utilizing pounds of flounder landed as the measure of fishing effort. Representative samples of fishing effort are critical when using this method to avoid inaccurate estimates of bycatch. The only major discrepancies detected between observed and reported flounder catch rates occurred during the sixth week in the shallow water fishery and the fourth week in the deep water fishery (Figure 6). During these weeks, observed CPUEs exceeded reported CPUEs. The source of these differences can be attributed to several observed trips with exceedingly high flounder catches, which is reflected in the large amount of error associated with the mean CPUEs for these weeks. This potentially resulted in underestimates of sea turtle bycatch for each fishery during those two weeks.

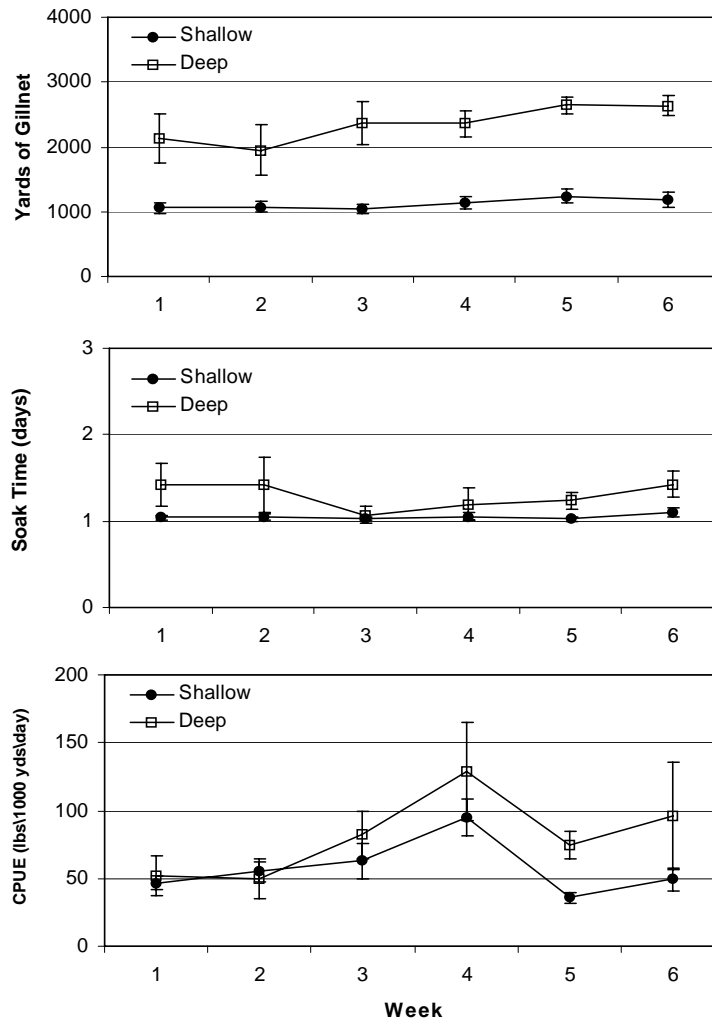


Figure 5. Mean (\pm 95% CI) yards of gillnet, soak time (days), and CPUE (lbs of flounder\1000 yards of gillnet\1 day soak) by week for the shallow and deep water Pamlico Sound flounder gillnet fisheries during the 2000 fishing season. Data are from weekly fishermen reports. Sample sizes are listed under *Trips* in Tables 6 and 7.

Table 8. Summary of shallow water flounder gillnet fishery observer coverage by week for the 2000 fishing season.

Week	Dates	Observed Trips	Total Trips	Percent Coverage	Observed Gillnet Yards	Total Gillnet Yards	Observed lbs Flounder	Total lbs Flounder
1	Sep-15 - Sep-22	6	131	4.6	5,500	134,110	344	6,655
2	Sep-23 - Sep-29	6	117	5.1	4,055	125,980	220	6,482
3	Sep-30 - Oct-06	10	168	6.0	12,220	174,800	695	10,542
4	Oct-07 - Oct-13	7	153	4.6	5,645	173,040	517	16,943
5	Oct-14 - Oct-20	5	190	2.6	4,210	235,990	125	7,812
6	Oct-21 - Oct-27	6	133	4.5	7,580	157,090	778	7,764
All	Sep-15 - Oct-27	40	892	4.5	39,210	1,001,010	2,679	56,198

Table 9. Summary of deep water flounder gillnet fishery observer coverage by week for the 2000 fishing season.

Week	Dates	Observed Trips	Total Trips	Percent Coverage	Observed Gillnet Yards	Total Gillnet Yards	Observed lbs Flounder	Total lbs Flounder
1	Sep-15 - Sep-22	3	26	11.5	7,850	55,400	817	3,301
2	Sep-23 - Sep-29	4	21	19.0	9,850	41,000	696	2,587
3	Sep-30 - Oct-06	4	29	13.8	10,600	68,750	684	6,398
4	Oct-07 - Oct-13	3	47	6.4	7,250	110,800	2,553	15,819
5	Oct-14 - Oct-20	5	85	5.9	14,000	224,700	1,342	20,619
6	Oct-21 - Oct-27	6	59	10.2	10,400	155,500	902	15,698
All	Sep-15 - Oct-27	25	267	9.4	59,950	656,150	6,994	64,422

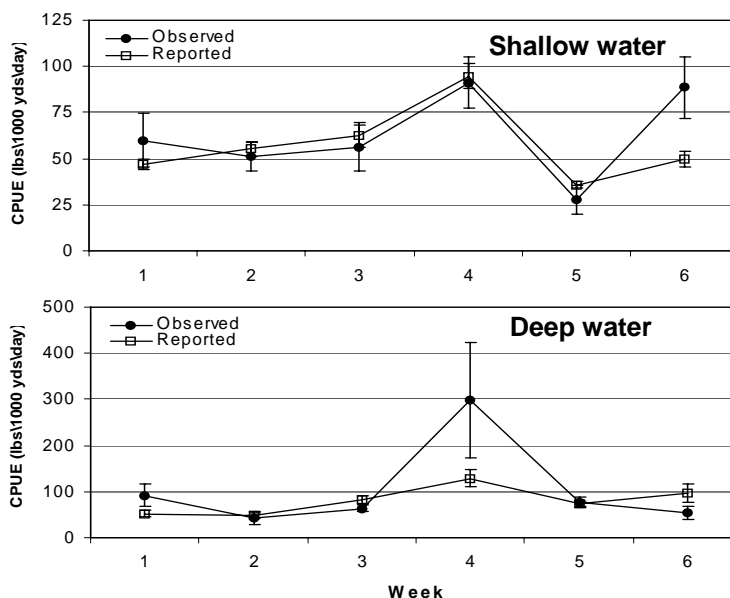


Figure 6. Mean (\pm SE) observed and reported flounder CPUEs (lbs/1000 yds/1 day soak) by week for the shallow and deep water flounder gillnet fisheries during the 2000 fishing season. Sample sizes are listed under *Observed Trips* and *Total Trips* in Tables 8 and 9.

Sea Turtle Bycatch

Nineteen sea turtle interactions were observed in the PSGNRA during the six week season. Four takes were observed in the shallow water fishery, while 15 occurred in the deep water fishery (Tables 10 and 11). Only green sea turtles were observed in the shallow water fishery, while Kemp's ridley, green, and loggerheads appeared in the deep water fishery (Tables 10 and 11). No takes were observed in the shallow water fishery after the third week of the season (Table 10). Interactions were observed in the deep water fishery during every week of the season (Table 11). Sea turtle mortality varied with only one green sea turtle mortality observed in the shallow water fishery and two loggerheads, two greens, and two Kemp's ridley sea turtle mortalities observed in the deep water fishery (Tables 10 and 11). Differences in mortality rates between fisheries can be attributed to differences in fishing practices and areas fished. The shallow water fishery operates in water depths less than three feet, which is conducive to sea turtle survival. When sea turtles are caught in this fishery, they are within easy reach of the surface and can frequently come up to breathe. In addition, nets are rarely soaked more than one day, which prevents incidentally caught sea turtles from being entangled and

potentially submerged for long periods of time. In contrast, the deep water fishery operates in water depths between 10 and 20 feet. This factor, combined with bottom fishing gillnets that are tied down to fishing heights of three to four feet, prevents entangled sea turtles from reaching the surface for air. In addition, soak times in the deep water fishery often approach two days, which causes incidentally caught sea turtles to remain in the net for longer periods of time.

Table 10. Observed sea turtle interactions in the shallow water flounder gillnet fishery in the PSGNRA during the 2000 fishing season.

Week	Dates	Loggerhead		Green		Kemp's Ridley	
		Live	Dead	Live	Dead	Live	Dead
1	Sep-15 - Sep-22	0	0	2	0	0	0
2	Sep-23 - Sep-29	0	0	0	0	0	0
3	Sep-30 - Oct-06	0	0	1	1	0	0
4	Oct-07 - Oct-13	0	0	0	0	0	0
5	Oct-14 - Oct-20	0	0	0	0	0	0
6	Oct-21 - Oct-27	0	0	0	0	0	0
All	Sep-15 - Oct-27	0	0	3	1	0	0

Table 11. Observed sea turtle interactions in the deep water flounder gillnet fishery in the PSGNRA during the 2000 fishing season.

Week	Dates	Loggerhead		Green		Kemp's Ridley	
		Live	Dead	Live	Dead	Live	Dead
1	Sep-15 - Sep-22	1	0	0	0	0	0
2	Sep-23 - Sep-29	1	2	0	0	0	0
3	Sep-30 - Oct-06	1	0	0	0	0	0
4	Oct-07 - Oct-13	2	0	0	0	1	0
5	Oct-14 - Oct-20	1	0	0	2	0	2
6	Oct-21 - Oct-27	1	0	0	0	1	0
All	Sep-15 - Oct-27	7	2	0	2	2	2

Spatial and temporal patterns of sea turtle interactions were difficult to identify due to the small number of turtles caught. Interactions with green turtles occurred in shallow water close to the inlets during the first three weeks of the season and in deep water during the fifth week (Figure 7). Loggerhead interactions were only observed in deep water areas and occurred throughout the season (Figure 7). Kemp's ridley interactions were also only observed in deep water areas but occurred during the final three weeks of the season (Figure 7). The green and Kemp's ridley turtles were juveniles, while most of the loggerheads were larger adults. There were no significant patterns to the interactions with most taking place in areas where fishing effort was clustered (Figure 8). However, a cold front passed through the area during the fourth week of the season causing water temperatures in the shallow water areas to drop substantially (Figure 9). The temperature drop coincided with a peak in flounder landings for the shallow water fishery (Table 8). Deep water fishing effort and landings peaked one week later during the fifth week (Table 9). Sea turtle interactions also peaked in the deep water fishery during the fifth week with five observed interactions and the first green turtle takes observed in the deep water fishery (Table 11). This data suggests that the temperature drop during the fourth week may have driven flounder and juvenile green turtles from the colder shallow water areas into the warmer deep water areas where fishing effort had hit its highest point during the season resulting in large flounder catches and higher levels of sea turtle interactions.

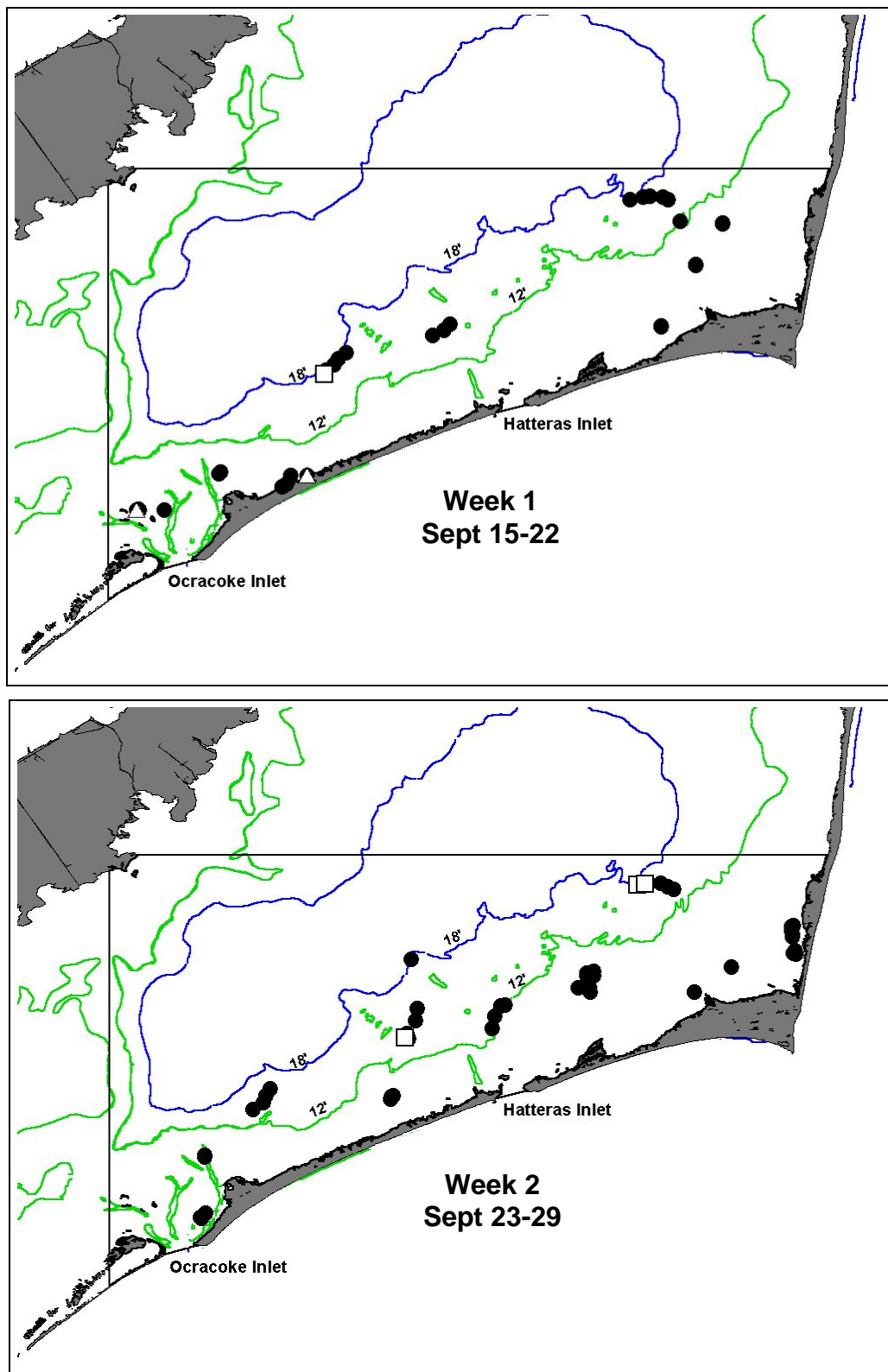


Figure 7. Weekly observed (□) loggerhead, (Δ) green, and (O) Kemp's ridley sea turtle interactions and observed large mesh (>5-inch stretched mesh) gillnet sets in southeastern Pamlico Sound from September 15 – October 27, 2000. PSGNRA borders and 12 and 18 foot contour lines are shown.

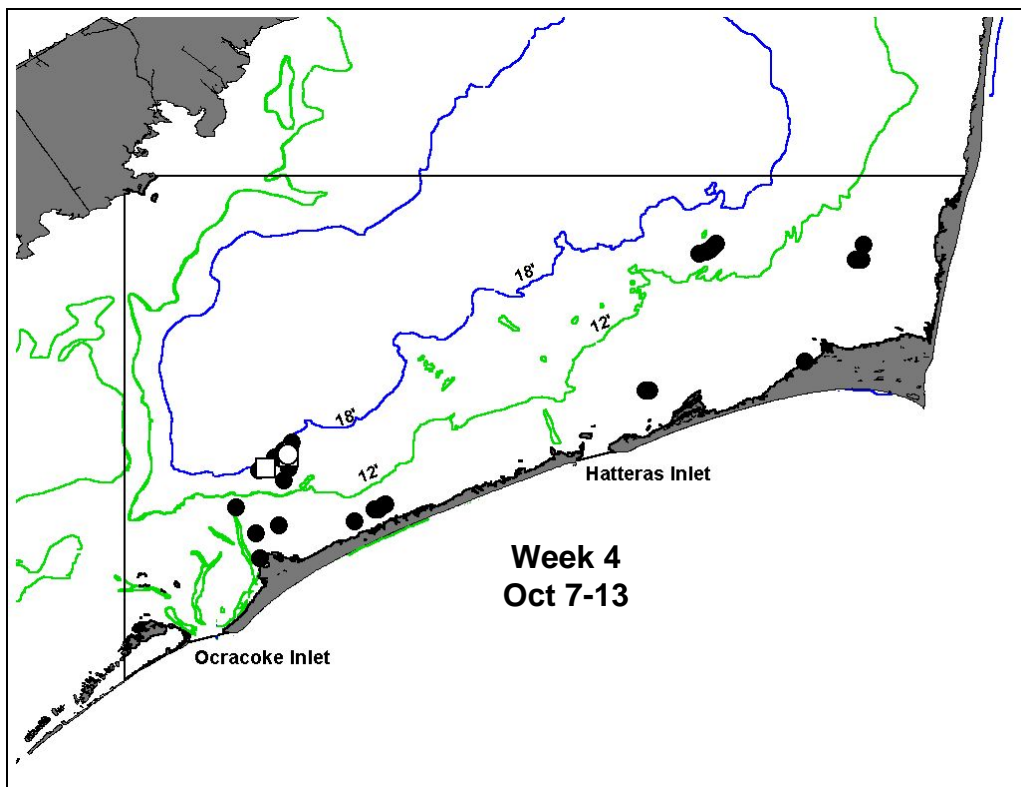
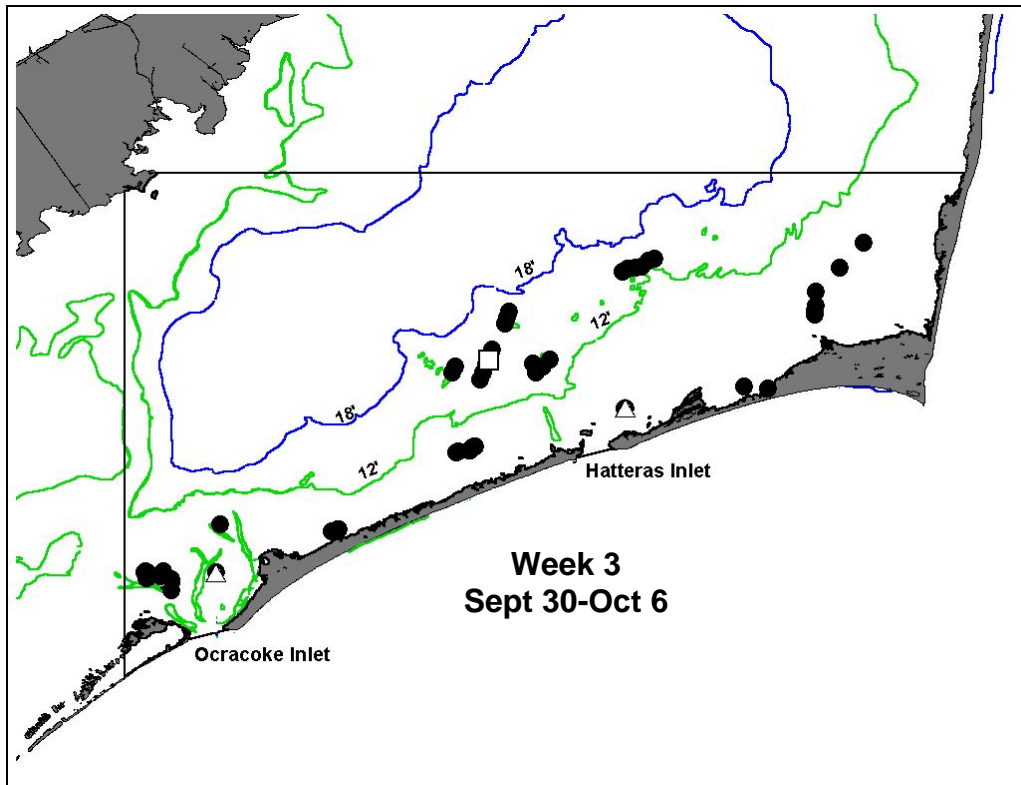


Figure 7. Continued.

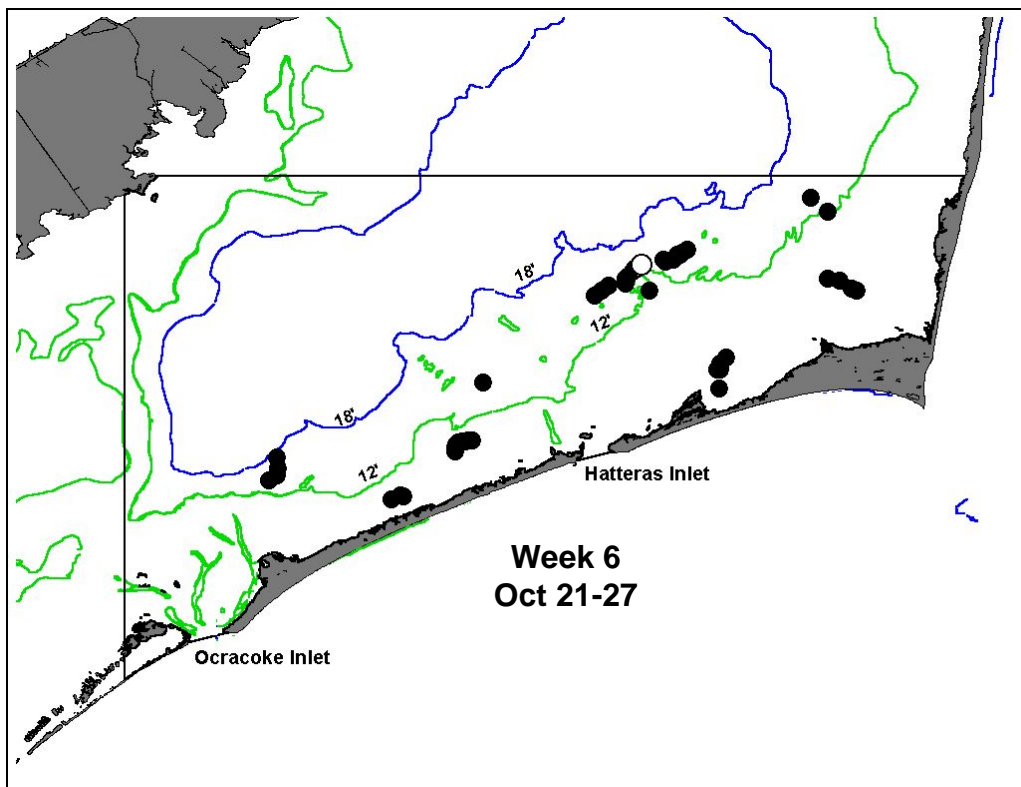
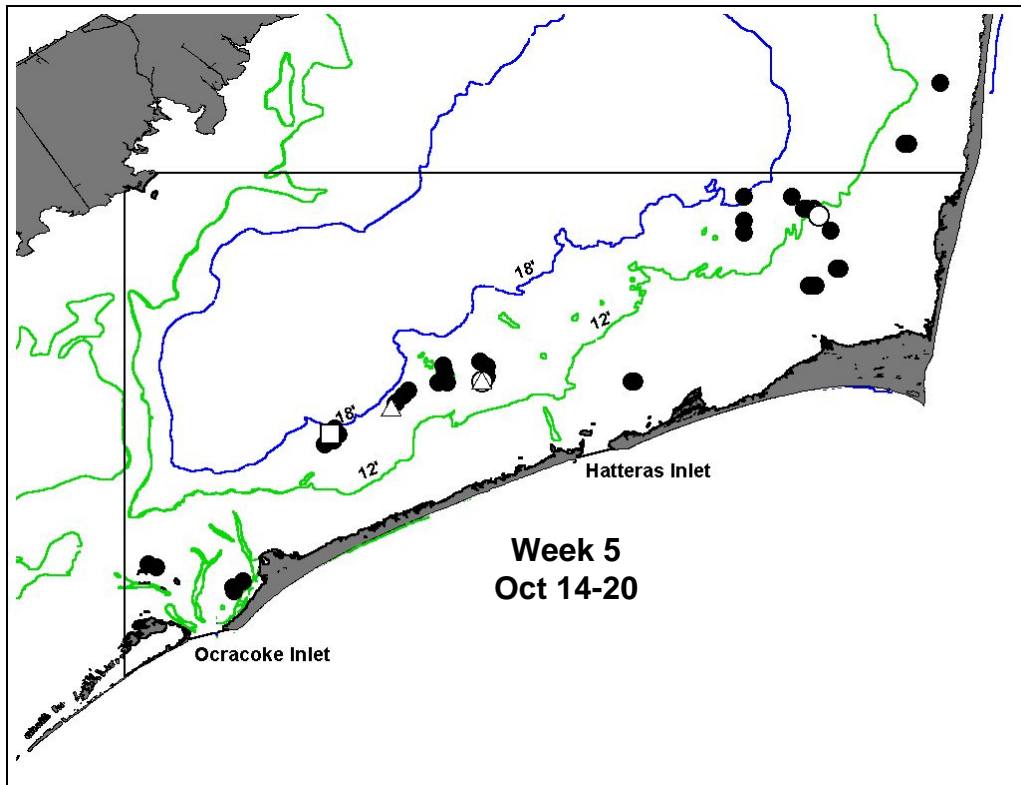


Figure 7. Continued.

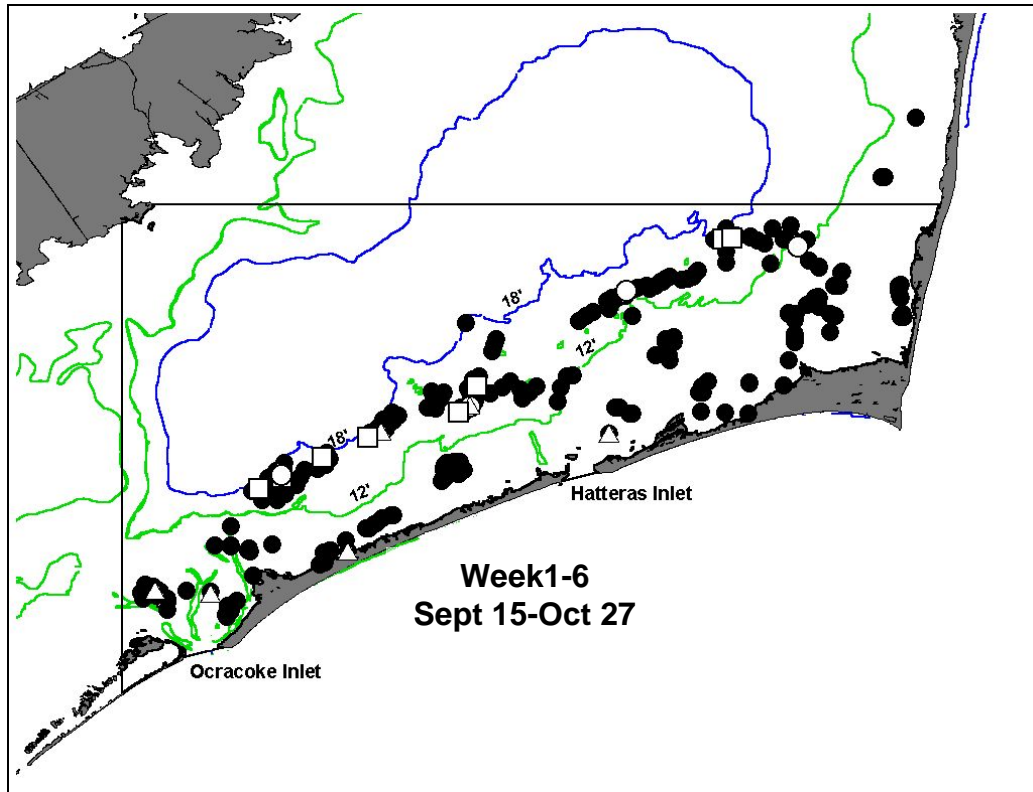


Figure 8. All observed (□) loggerhead, (Δ) green, and (O) Kemp's ridley sea turtle interactions and observed large mesh (>5-inch stretched mesh) gillnet sets in southeastern Pamlico Sound from September 15 – October 27, 2000. PSGNRA borders and 12 and 18 foot contour lines are shown.

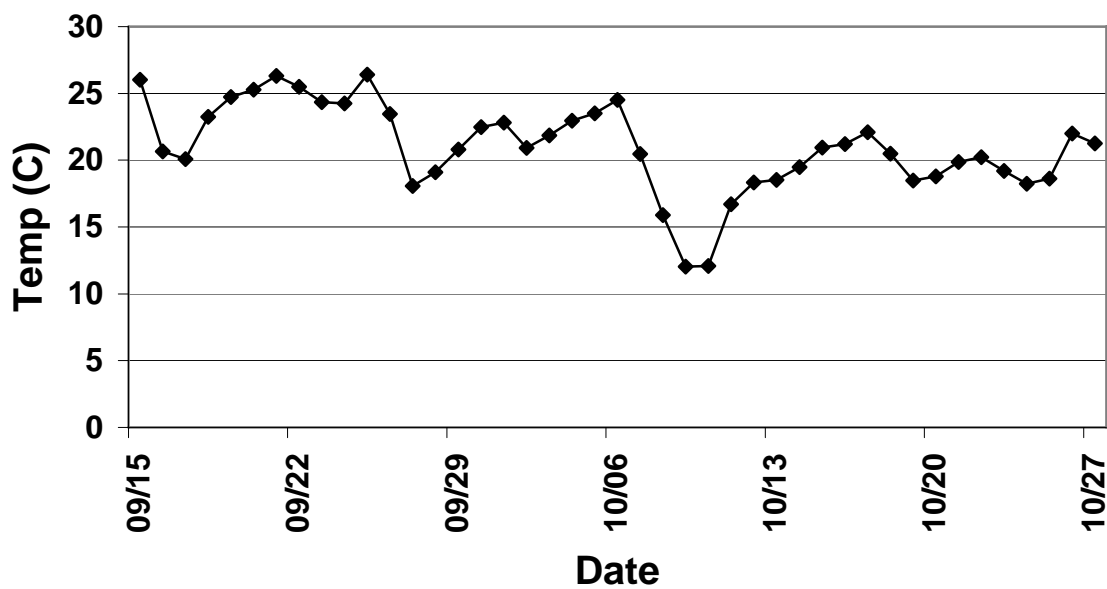


Figure 9. Average daily air temperature (°C) for Diamond Shoals Light, NC from September 15-October 27, 2000 (National Weather Service, National Data Buoy Center, DSLN7).

Sea turtle bycatch estimates were calculated using the stratified ratio method. The strata were defined by the shallow and deep water gillnet fisheries. The total sea turtle bycatch estimate was 206 turtles consisting of 52 loggerheads, 100 green, and 54 Kemp's ridley. The shallow water fishery contributed 69 green turtles to this total (Table 12). The deep water fishery estimate was 137 turtles composed of 52 loggerheads, 31 green, and 54 Kemp's ridley (Table 13). These estimates may be low due to potentially misrepresentative large flounder catches observed in the deep water fishery during the fourth week of the season (Figure 6). In addition, these estimates do not account for underestimates of total fishing effort resulting from failed reporting, which was 10.2% across the season (Table 5). Furthermore, verification of reported landings with Trip Tickets was not performed before calculating these estimates. Landings data for 2000 were not available during the writing of this report. When Trip Ticket data are available, reported landings verification may be difficult in some cases. Portions of some catches were kept for personal consumption and not listed on Trip Tickets. In addition, some fishermen hold catches for several days resulting in landings from multiple trips listed on a single Trip Ticket.

One important factor to consider when using the stratified ratio method of bycatch estimation is the measure of fishing effort. Flounder landings were used in this study while a more accurate and less variable measure of effort for these fisheries is length of net x soak time (Figure 10). The coefficient of variation (CV) for observed flounder landings in the deep water fishery was 22.8, while the per trip observed gear effort (yards x soak) CV was 9.9. The CVs for the shallow water fishery were 13.4 for flounder landings and 6.8 for gear effort. This less variable measure of fishing effort would reduce the risk of under or overestimating bycatch. While gear effort may better represent effort for these fisheries, verification of this reported data would be difficult. Fishermen were required to report yards of net fished and soak time as a provision of their permit but this information is not captured on Trip Tickets. This was the primary reason for using pounds of flounder landed as the measure of fishing effort.

Regardless of the unit of effort used, the stratified ratio method has inherent problems when trying to estimate rare event bycatch such as protected species. Other estimation techniques have been employed in similar studies to deal with the issues associated with these types of data. The data from this study, like many others that try to estimate protected species bycatch, contains a large proportion of zeros. In these studies, when using the sample mean as an estimator of abundance there is often a large amount of variance associated with the sample mean. A more appropriate method may be the delta lognormal method of estimation (Pennington 1983). This technique deals with the issue of many zeros by treating the nonzero data separately to provide a more efficient estimation of abundance by providing minimum variance unbiased estimators of means and variances.

CONCLUSIONS

The deep water gillnet fishery accounted for the majority of the interactions and was ultimately responsible for the takes that required the closure of the PSGNRA. In addition, the highest percentage of lethal takes were observed in the deep water fishery, which can be attributed to a combination of specific gear characteristics, water depth, and fishing practices.

Table 12. Sea turtle catch rates (observed turtles\1000 lbs of flounder) and estimates by week for the shallow water flounder gillnet fishery in the PSGNRA during the 2000 fishing season.

Week	Dates	Loggerhead				Green				Kemp's Ridley			
		Live		Dead		Live		Dead		Live		Dead	
		Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate
1	Sep-15 - Sep-22	0	0	0	0	5.8	38.7	0	0	0	0	0	0
2	Sep-23 - Sep-29	0	0	0	0	0	0	0	0	0	0	0	0
3	Sep-30 - Oct-06	0	0	0	0	1.4	15.2	1.4	15.2	0	0	0	0
4	Oct-07 - Oct-13	0	0	0	0	0	0	0	0	0	0	0	0
5	Oct-14 - Oct-20	0	0	0	0	0	0	0	0	0	0	0	0
6	Oct-21 - Oct-27	0	0	0	0	0	0	0	0	0	0	0	0
Total	Sep-15 - Oct-27		0		0		53.9		15.2		0		0

Table 13. Sea turtle catch rates (observed turtles\1000 lbs of flounder) and estimates by week for the deep water flounder gillnet fishery in the PSGNRA during the 2000 fishing season.

Week	Dates	Loggerhead				Green				Kemp's Ridley			
		Live		Dead		Live		Dead		Live		Dead	
		Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate	Rate	Estimate
1	Sep-15 - Sep-22	1.2	4.0	0	0	0	0	0	0	0	0	0	0
2	Sep-23 - Sep-29	1.4	3.7	2.9	7.4	0	0	0	0	0	0	0	0
3	Sep-30 - Oct-06	1.5	9.4	0	0	0	0	0	0	0	0	0	0
4	Oct-07 - Oct-13	0.8	12.4	0	0	0	0	0	0	0.4	6.2	0	0
5	Oct-14 - Oct-20	0.7	15.4	0	0	0	0	1.5	30.7	0	0	1.5	30.7
6	Oct-21 - Oct-27	0	0	0	0	0	0	0	0	1.1	17.4	0	0
Total	Sep-15 - Oct-27		44.9		7.4		0		30.7		23.6		30.7

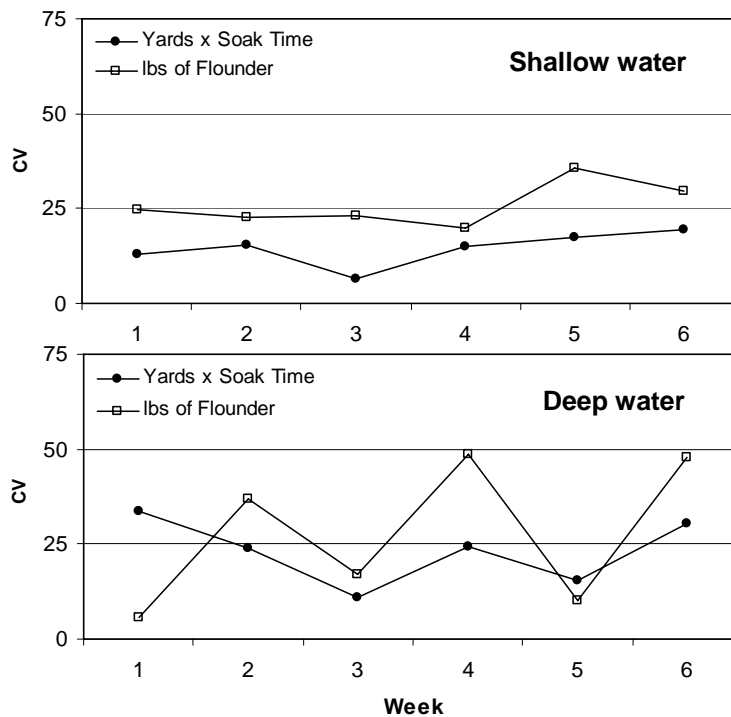


Figure 10. Coefficients of variation (CV) for observed fishing effort (lbs of flounder and gillnet yards x soak days) by week for the shallow and deep water flounder gillnet fisheries of Pamlico Sound during the 2000 fishing season. Sample sizes are listed in Tables 8 and 9 under *Observed Trips*.

The gear used in the deep water fishery consists of large mesh (> 5-inch stretched) gillnets with fishing heights of approximately ten feet that are tied down to fishing heights of three to four feet. This results in loose webbing throughout the gear, which is ideal for catching flounder. The inherent problem with this gear is that when sea turtles interactions occur in water depths greater than a few feet deep the likelihood of their survival is diminished. This is especially true when nets are left for extended periods and are only visited every other day. The practice of leaving nets for extended periods is a common practice in the deep water fishery. Early in the season, when water temperatures are warmer, soak times are generally shorter due to the risk of spoilage. However, as the season progresses and water temperatures cool, soak times become longer maximizing the amount of catch per trip and lowering operational costs of fuel and time. In addition to extended soak times, the practice of setting large amounts of gear has been common in this fishery with some vessels setting up to 10,000 yards of gillnet. This practice also contributes to extended soak times because, depending on catch levels, this is generally more gear than one vessel, equipped with a net reel, can fish in one day.

In contrast, the shallow water fishery, which uses gear with the same characteristics, sets nets in water depths less than three feet. Small vessels are used, which lends to the practice of setting smaller amounts of gear. The maximum amount of gear usually does not exceed 2,000 yards per vessel. This amount of gear, depending on catch levels, can be fished by hand in a single day. Travel distances for this fishery are generally less than five miles and one or two man crews are used. The combination of smaller amounts of gear, smaller vessels, and shorter distances to travel translates to lower operational costs for each vessel and the ability to fish nets on a daily basis. Short soak times and shallow water common to this fishery lends to good survival rates of incidentally caught sea turtles.

The PSGNRA was closed to large mesh gillnets on October 27, 2000 because the estimated live take threshold for green turtles was reached requiring a level four management response (Table 14).

Table 14. Estimated and allowed thresholds for lethal and live takes by species from September 15-October 27, 2000 in the PSGNRA. Level four management responses required.

Species	Threshold Live Takes	Estimated Live Takes	Threshold Lethal Takes	Estimated Lethal Takes
Kemp's ridley	192	24	96	31
Green	72	54	36	46
Loggerhead	112	45	56	7
Species in Aggregate	350	122	175	84

The goal of the Conservation Plan was to reduce all sea turtle strandings in the PSGNRA by 50% during the 2000 fishing season relative to the 1999 season. Stranding thresholds and allowable takes were set by species for the 2000 season based on 1999 strandings. Setting thresholds by species in 2000 relative to the species composition of 1999 strandings assumes that the species composition of turtles in Pamlico Sound during the 2000 fishing season would be the same as 1999. During 1999, fewer green turtles stranded in the PSGNRA than any other species, while Kemp's ridley turtles accounted for the largest percentage of strandings. This resulted in high thresholds for the Kemp's ridley turtles and low thresholds for green turtles. During the 2000 season, few Kemp's ridley turtles were observed, while green turtles were the second most abundant species (Tables 10 and 11). This caused the low thresholds set for green turtles to be exceeded before any alternative management responses could be taken. As an alternative, species aggregate thresholds would have prevented the premature closing of the fishery, which would have allowed fisheries managers more reaction time. This would have provided the time needed to implement restrictions aimed at reducing interactions while allowing limited fishing opportunities. Extra time would have also provided for the collection of additional observer data enabling NCDMF to better manage this fishery in the future.

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